

## CLAIMS

What is claimed is:

1. A friction stir welding system that is capable of functionally friction stir welding high melting temperature ferrous and non-ferrous alloys, and superalloys, in a non-planar weld, said friction stir welding system comprising:

    a friction stir welding tool having a superabrasive material disposed on at least a portion thereof the shoulder and the pin, wherein the superabrasive material has a first phase and a secondary phase, wherein the friction stir welding tool is disposed on an outer diameter (OD) of a non-planar surface of a pipe;

    a cooling system disposed so as to provide cooling to the friction stir welding tool; and

    a support mandrel disposed against an inner diameter (ID) of the pipe so as to counteract a force applied by the friction stir welding tool to the OD, wherein the support mandrel includes a coating to prevent diffusion bonding with the with the pipe.